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The sum of the squares of the residuals is largely reduced; indeed, for our first set of elements it was 52·31 for $\theta$ and 0·0342 for $\rho$. For the new elements we have 26·13 for $\theta$ and 0·0111 for $\rho$.

In both angle and distance the sum of the squares has diminished very considerably. Therefore the new system of elements must be considered as representing much better the true orbit of 9 *Argûs.*

With these new elements the following positions of the satellite for several years have been calculated:—

| $t$ | $\theta$ | $\rho$ | $t$ | $\theta$ | $\rho$ |
|---|---|---|---|---|---|
| | ° | ″ | | ° | ″ |
| 1894·0 | 273·8 | 0·32 | 97·0 | 285·9 | 0·57 |
| 95·0 | 279·6 | 0·46 | 98·0 | 288·5 | 0·58 |
| 96·0 | 283·1 | 0·54 | 99·0 | 291·1 | 0·57 |

The angular velocity is increasing, and between 1892 and 1894 the angle of position has changed 180°: therefore each observation obtained during the present and next years will be of great value for the investigation of the orbit; but 9 *Argûs* belongs to the most difficult double stars, and is accessible only to the most powerful telescopes placed in perfect conditions.

*St. Petersburg,*
*Observatory of the Imperial University:*
1894 *March* 4.

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## *On the Proper Motion of Stars in the Dumbbell Nebula.* By Professor Arthur A. Rambaut, M.A., Sc.D., and W. E. Wilson, F.R.A.S.

Most photographs of the Dumbbell Nebula in *Vulpecula* (M. 27, N.G.C. 6853) represent the brighter portion of it as being of a sort of hour-glass form or approximately the figure which would be formed by two opposite sectors of a circle of about 60° each. The stars, too, which are found in the nebula are not distributed wholly without relation to the form of the latter, for it is a remarkable fact that exactly at the common centre of the two sectors, or the neck of the hour-glass, a comparatively conspicuous star is placed, while the extremities of each of the bounding arcs are approximately indicated by stellar points. These stars are respectively *d*, *a*, *m*, *o*, and *c* in the figure.

In the *Philosophical Transactions of the Royal Society*, Vol. 151, Part III., the Earl of Rosse publishes a note on the positions of twenty-six stars as determined at the Poulkova

Observatory by M. Otto Struve, in which the latter expresses his conviction that the probable error in the coordinates will be considerably less than one second of arc. As some of these stars lie outside the region over which the nebula extends on the photographs or that which it occupies on the Parsonstown drawing it appears an interesting inquiry whether those stars apparently related to the nebula indicate any proper motion, as compared with those lying outside it, in the forty-two years which have elapsed since M. Struve's measures were made.

In order to investigate this question we measured two photographs taken with the 2-foot equatorial reflector belonging to Mr. Wilson on 1893 September 3 and 8, with exposures of $27^m$ and $2^h$ respectively.

The plates were examined in the measuring microscope of the Dunsink Observatory, in which the coordinates are determined on two screws at right angles to each other. The plates were placed in position in the microscope by means of the relative positions determined by M. Struve for the stars *a* and *s* of his list, so that each screw was parallel to one of the axes of coordinates employed by that astronomer. The scale value of the photograph, too, was determined from the value of $\Delta\alpha \cos \delta$ given by him for the same stars, which, depending as it does on a larger number of observations than the other measures, is the best determined interval in the group, besides being very nearly the longest. Consequently any error affecting its length will be felt to a smaller extent in the measures of any other interval.

Our coordinates are thus directly comparable with those of M. Struve, our axis on the plate being, by the above process, set in the direction of the parallel passing through *a* at the date of his observations. The correction for refraction has not been applied, as it was found that in no case would its effect amount to a tenth of a second of arc, and the measures, though probably correct to within two or three tenths of a second, could hardly be relied on to a higher degree of accuracy.

A comparison of our results with those obtained by Mr. Bindon Stoney, using the 6-foot reflector belonging to the Earl of Rosse, and with those of M. Struve, is given in Table II. The former cannot be depended on with any high degree of precision on account of a difficulty in determining the parallel arising from the altazimuth form of the great reflector. They are, however, given in the table, as in several cases they point to the existence of a proper motion in the same direction as is deduced from a comparison of our measures with those of M. Struve.

It will be seen from the columns headed $X_s - X_w$ and $Y_s - Y_w$ that in most cases there are discrepancies which can hardly be attributed to errors of observation. These would indicate in the case of the stars *p*, *d*, *k*, *i*, *b'*, and *y* proper motions amounting in forty-two years to $4''{\cdot}6$, $3''{\cdot}9$, $5''{\cdot}7$, $6''{\cdot}0$, $5''{\cdot}2$, and $5''{\cdot}3$ respectively.

It does not seem, however, that there is any obvious relation

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between the position which a star bears with regard to the nebula and the amount or direction of its proper motion, but further observations will be necessary to decide this point.

In the accompanying plate the positions of the stars are plotted down from our measures, and the form of the nebula is indicated in outline to facilitate the identification of the stars.

Table I.—*Coordinates of Stars in the Dumbbell Nebula.*

| Name. | X | Y | Name. | X | Y |
|---|---|---|---|---|---|
| | ″ | ″ | | ″ | ″ |
| *q* | − 94·4 | − 20·6 | *h* | + 247·1 | + 102·6 |
| | 94·4 | 20·6 | | 246·7 | 104·4 |
| | − 94·4 | − 20·6 | | + 246·9 | + 103·5 |
| *a′* | − 9·9 | − 58·1 | *z* | 276·6 | − 197·1 |
| | 9·2 | 56·8 | | 275·9 | 196·8 |
| | − 9·6 | − 57·5 | | 276·3 | − 197·0 |
| *b* | + 21·9 | + 199·1 | *b′* | 302·8 | + 187·5 |
| | 22·7 | 199·2 | | 303·4 | 186·8 |
| | + 22·3 | + 199·1 | | 303·1 | + 187·2 |
| *o* | 47·5 | + 145·5 | *w* | 316·2 | − 102·7 |
| | 49·0 | 145·6 | | 315·8 | 101·2 |
| | 48·2 | 145·5 | | 316·0 | − 102·0 |
| *p* | 56·4 | + 59·6 | *c* | 317·6 | + 63·9 |
| | 56·9 | 60·6 | | 317·2 | 64·3 |
| | 56·6 | + 60·1 | | 317·4 | + 64·1 |
| *d* | 151·7 | + 16·9 | *y* | 317·2 | − 216·5 |
| | 151·3 | 16·3 | | 317·4 | 217·1 |
| | 151·5 | + 16·6 | | 317·3 | − 216·8 |
| *e* | 169·8 | + 99·9 | *l* | 328·5 | − 160·5 |
| | 169·5 | 100·5 | | 328·2 | 160·2 |
| | 169·7 | + 100·2 | | 328·4 | 160·4 |
| *g* | 171·9 | + 192·8 | *t* | 345·3 | − 132·2 |
| | 172·3 | 193·0 | | 344·4 | 131·3 |
| | 172·1 | + 192·9 | | + 344·9 | − 131·8 |

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| Name. | X | Y | Name. | X | Y |
|---|---|---|---|---|---|
| *f* | 171″·4 | +146″·9 | *v* | +386″·9 | −162″·3 |
| | 170·8 | 146·6 | | 387·2 | 161·5 |
| | 171·1 | +146·8 | | 387·0 | −161·9 |
| *k* | 183·0 | −116·7 | *r* | 396·6 | −72·8 |
| | 182·5 | 117·3 | | 396·6 | 72·5 |
| | 182·8 | −117·0 | | 396·6 | −72·7 |
| *n* | 223·3 | −183·7 | *u* | 398·9 | −198·0 |
| | 222·8 | 184·1 | | 398·9 | −198·2 |
| | 223·1 | −183·9 | | 398·9 | −198·1 |
| *m* | 223·6 | −163·7 | *x* | 442·3 | −146·7 |
| | 222·7 | 164·2 | | 442·7 | 145·6 |
| | 223·2 | −163·9 | | 442·5 | −146·2 |
| *i* | 232·8 | +73·6 | *s* | 555·8 | −41·7 |
| | 233·1 | 75·0 | | 555·8 | −42·2 |
| | 232·9 | +74·3 | | +555·8 | −41·9 |

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TABLE II.—*Comparison of Measures.*

| | *Wilson.* | | *Rosse.* | | | | *Struve.* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Name. | $X_w$ | $Y_w$ | $X_r$ | $X_r-X_w$ | $Y_r$ | $Y_r-Y_w$ | $X_s$ | $X_s-X_w$ | $Y_s$ | $Y_s-Y_w$ | |
| | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| *q* | − 94·4 | − 20·6 | ... | ... | ... | ... | − 97·6 | −3·2 | − 20·9 | −0·3 | |
| *a′* | − 9·6 | − 57·5 | − 10·9 | −1·3 | − 59·8 | − 2·3 | − 12·3 | −2·7 | − 57·2 | +0·3 | v. v. f. |
| *b* | + 22·3 | +199·1 | + 23·0 | +0·7 | +199·7 | + 0·6 | + 21·6 | −0·7 | +199·7 | +0·6 | |
| *o* | 48·2 | +145·5 | 46·8 | −1·4 | +149·5 | + 4·0 | + 49·6 | +1·4 | +144·0 | −1·5 | |
| *p* | 56·6 | + 60·1 | 48·1 | −8·5 | + 61·3 | + 1·2 | + 60·6 | +4·0 | + 57·9 | −2·2 | Ill defined. |
| *d* | 151·5 | + 16·6 | 154·4 | +2·9 | + 17·5 | + 0·9 | +152·5 | +1·0 | + 12·8 | −3·8 | = *a* in mag. |
| *e* | 169·7 | +100·2 | 172·8 | +3·1 | + 98·6 | − 1·6 | +172·5 | +2·8 | + 98·8 | −1·4 | |
| *g* | 172·1 | +192·9 | 173·9 | +1·8 | +193·2 | + 0·3 | +174·3 | +2·2 | +191·5 | −1·4 | v. v. f. |
| *f* | 171·1 | +146·8 | 172·3 | +1·2 | +144·5 | − 2·3 | +174·6 | +3·5 | +142·2 | −4·6 | |
| *k* | 182·8 | −117·0 | 187·4 | +4·6 | −121·3 | − 4·3 | +186·8 | +4·0 | −121·0 | −4·0 | |
| *n* | 223·1 | −183·9 | ... | ... | ... | ... | +224·9 | +1·8 | −184·7 | −0·8 | |
| *m* | 223·2 | −163·9 | ... | ... | ... | ... | +225·0 | +1·8 | −164·3 | −0·4 | |
| *i* | 232·9 | + 74·3 | 235·8 | +2·9 | + 70·8 | − 3·5 | +238·2 | +5·3 | + 71·5 | −2·8 | > *h*. |
| *h* | 246·9 | +103·5 | 246·2 | −0·7 | +100·5 | − 3·0 | +251·1 | +4·2 | +101·7 | −1·8 | v. nebulous. |
| *z* | 276·3 | −197·0 | ... | ... | ... | ... | +279·6 | +3·3 | −199·7 | −2·7 | |
| *b′* | 303·1 | +187·2 | 303·6 | +0·5 | +183·4 | − 3·8 | +308·3 | +5·2 | +186·3 | −0·9 | |
| *w* | 316·0 | −102·0 | 323·5 | +7·5 | −115·0 | −13·0 | +317·7 | +1·7 | −102·0 | 0·0 | |
| *c* | 317·4 | + 64·1 | 325·3 | +7·9 | + 63·1 | − 1·0 | +321·1 | +3·7 | + 62·8 | −1·3 | |
| *y* | 317·3 | −216·8 | ... | ... | ... | ... | +321·8 | +4·5 | −219·5 | −2·7 | |
| *l* | 328·4 | −160·4 | ... | ... | ... | ... | +332·4 | +4·0 | −162·2 | −1·8 | |
| *t* | 344·9 | −131·8 | ... | ... | ... | ... | +347·8 | +2·9 | −128·9 | +2·9 | Ill defined. |
| *v* | 387·0 | −161·9 | ... | ... | ... | ... | +390·7 | +3·7 | −161·7 | +0·2 | |
| *r* | 396·6 | − 72·7 | 398·2 | +1·6 | − 91·6 | −18·9 | +396·9 | +0·3 | − 74·0 | −1·3 | |
| *u* | 398·9 | −198·1 | ... | ... | ... | ... | +402·4 | +3·5 | −200·8 | −2·7 | |
| *x* | 442·5 | −146·2 | ... | ... | ... | ... | +442·0 | −0·5 | −148·5 | −2·3 | v. v. f. |
| *s* | +555·8 | − 41·9 | ... | ... | ... | ... | +555·8 | 0·0 | − 42·0 | −0·1 | |

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# *Note on the Star* DM + 27°·725. By A. M. W. Downing, M.A., D.Sc.

This star was selected as one of the *Nautical Almanac* zodiacal stars on the authority of the Harvard Photometry, where it appears as No. 893 of the General Catalogue, with magnitude 6·3. The magnitude 5·9 assigned to the star in the DM is a misprint for 9·5, as is explained in *B. B.* vi. p. 378.* And as a tolerably comprehensive search failed to find the star in any modern catalogue it appears probable that the Harvard observations, assigned to this star, really refer to some other object. This view is confirmed by the evidence afforded by a photographic plate which the Astronomer Royal most kindly had taken for the express purpose of identifying the star. It was found, on examining the plate, that the object nearest the assigned place was fainter than the 9th mag. Professor Pickering has also been so good as to furnish information bearing on the subject derived from photographs taken on 1890 December 29, 1892 January 8 and December 28, and 1893 October 5. On these plates the star appears to be of about the 10th mag., and shows no evidence of variation. It may be concluded, therefore, that the mag. 9·5 assigned to this star by the Bonn observers is correct, and that the Harvard measures refer to some other object.

That the object measured at Harvard College was not the neighbouring star DM + 27°·723 appears probable from the results of measures of the latter object which Professor Pickering has kindly communicated. The mean of four measures gives 6·6 as the magnitude of this star.

The star DM + 27°·725 ought not, therefore, to have been included in the *Nautical Almanac* list of zodiacal stars (which is restricted to stars of magnitude not fainter than 6·5), and should be struck out wherever it appears in the Occultation Section of the *Nautical Almanacs* for 1896 and 1897, as well as in the Catalogue of Zodiacal Stars printed in the appendix to the last-named volume.

*Nautical Almanac Office :*
1894 *March* 5.

* Mr. Chandler also points this out in *Ast. Nach.* No. 3214.